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Heating of He^{++} ions by dissipation of parallel and oblique Alfvénic turbulence

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Turbulent magnetic field fluctuations with different power law spectra have been ubiquitously observed in the solar wind streams at various heliocentric distances starting at 0.3AU, passing Earth's orbit at 1AU and continuing beyond up to 5AU. The dissipation of fluid scale fluctuations in a collisionless plasma can occur via large-scale turbulent cascade, followed by various small-scale wave-particle interactions. The partitioning of energy between minor ions, protons and electrons and the efficiency of their heating depends on the characteristics of the waves, the wave vector direction and the anisotropy of the fluctuations carrying energy at small scales. One way to view the solar wind turbulence at ion scales is as a superposition of large-scale Alfvén waves, ion-cyclotron waves, kinetic Alfvén waves and some portion of acoustic (density) fluctuations, as well as very low-frequency whistlers. These waves are frequently observed in situ in the solar wind, and yet their specific role for the energetization of minor ions remains unclear. In this study we perform 2.5D hybrid simulations to study the importance of parallel and obliquely propagating Alfvén-cyclotron waves for the anisotropic heating of minor ions in the solar wind. We start with initially isotropic plasma with equal temperatures for the protons and He^{++} ions and impose an initial turbulent spectrum of Alfvén-cyclotron waves to subsequently follow the preferential heating for the minor ions and the onset of temperature anisotropies for both ion species. For the chosen set of plasma parameters, which are typical for finite-β fast solar wind, the parallel waves appear more efficient in heating of the minor ions than the oblique waves. In the course of the nonlinear evolution of the system when an initial parallel wave spectrum is assumed we observe a substaintial anisotropic cascade of the magnetic field power spectrum towards perpendicular wave numbers.